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ABSTRACT

This practicum describes a computer assisted instructional (CAI) program written in the computer language BASIC. This computer program was designed to help 11th and 12th grade algebra students (n=15) better understand the concept of linear equations. The program has three sections: the first is a tutorial, the second section gives the student the opportunity to answer questions on linear equations with immediate feedback, and the last section is a test. With this CAI program, teachers will have an alternative method of teaching algebra other than with a textbook and chalkboard. After 4 weeks of use, students in the target group showed significant gains in their abilities to write linear equations. Included in this study are the purpose, research and solution strategy, methodology, results as well as a copy of an attitudinal survey, and recommendations. Appended are test results from the district, school, and classroom, copy of the pretest and posttest, instructions for utilizing the CAI program, and a flowchart of the program. (Author/KR)

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ED326386

INCREASING THE SKILL AND KNOWLEDGE LEVEL OF LOW LEVEL STUDENTS ON LINEAR EQUATIONS

By

Kenneth G. Handelsman

U.S. DEPARTMENT OF EDUCATION
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A Practicum Report

submitted to the Faculty of the Center for the Advancement of Education of Nova University in partial fulfillment of the requirements for the degree of Master of Science.

The abstract of this report may be placed in a National Database System for reference

May/1989

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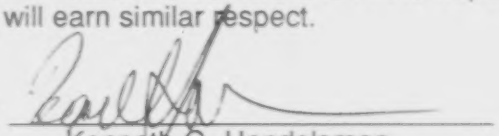
AUTHORSHIP STATEMENT

I hereby testify that this paper and the work it reports are entirely my own. When it has been necessary to draw from the work of others, published or unpublished, I have acknowledged such work in accordance with accepted scholarly and editorial practice. I give this testimony freely, out of respect for the scholarship of other workers in the field and in the hope that my own work, presented here, will earn similar respect.

Signed: 

Kenneth G. Handelsman

ABSTRACT

Increasing the Skill and Knowledge Level of Low Level Students on Linear Equations.
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In the 1987-88 school year all regular algebra classes were administered a county wide test. The test results showed that only 42 percent of the students answered the questions on linear equations correctly. Further research discovered that this problem is not unique to the school system. Based on similar test results, students throughout the country answered less than 50 percent of the questions on linear equations correctly.

The practitioner's practicum is a Computer Assisted Instruction (CAI) program written in the computer language BASIC. This computer program is designed to help eleventh and twelfth grade algebra students better understand the concept of linear equations. The program has three sections. The first section is a tutorial, the second section gives the student the opportunity to answer questions on linear equations with immediate feedback, and the last section is a test.

With this CAI; teachers will have an alternative method of teaching algebra other than the use of a textbook and chalkboard.

CHAPTER I

PURPOSE

The setting for this practicum was a public, comprehensive four year high school with an enrollment of approximately 2,400 students in grades nine through twelve. The student body is a significantly mobile tri-racial, multi-ethnic population that represents socio-economic groups ranging from low income to high income. Based on 1987-88 school year statistics, the racial and ethnic student composition is 27 percent white (non-Hispanic), 19 percent black (non-Hispanic), 53 percent Hispanic, and one percent asian.

The large percentage of transient students is a leading contributor to the poor school ranking in attendance. Out of 26 high schools in the district, the school in question ranks twenty-fifth. In spite of this negative statistic in attendance, the school's Functional Literacy Test scores were vastly improved from the school year of 1987-88. The percentage of students passing the communication portion of the Functional Literacy Test increased from 77 percent to 84 percent. During the same year, the percentage of students passing the mathematics portion of the Functional Literacy Test also increased from 84 percent to 88 percent.

In the spring of 1984, the Florida Legislature passed a bill which would reward "merit schools." This particular school has ranked as one of the top five senior high schools in the system for the past three years

as measured by gains in student achievement beyond predicted levels according to Stanford Achievement Test results.

Beginning in 1987, the school district initiated the district's academy of the teaching arts. The district's academy of the teaching arts allows teachers with five or more years of experience to learn from other experienced teachers within the system. This innovative program's main office is located at the school in which this writer is employed and this practicum will be implemented.

A wide range of required and elective courses are made available to meet the needs of all mathematics students. The mathematics curriculum ranges from compensatory education classes to calculus classes. The Computer Education Department is incorporated within the mathematics department. Computer classes range from Computer Literacy for beginners to Computer Programming in BASIC and PASCAL to facilitate the more advanced students. This writer's responsibilities involve teaching 150 mathematics students divided into five, fifty-minute classes ranging from compensatory education to Algebra I.

The Stanford Achievement Test (SAT), from which stanine scores are obtained, is administered annually to all students in grades seven through eleven. Stanines measure a student's ability level in communication and mathematic skills. Teachers and counselors traditionally have used these test results for placement purposes. The scores range from one, which is the lowest, to nine, which is the highest.

The test is curved so that 50 percent of the student's scores range from four to six.

In the SAT administered to 333 students in the 1987-88 school year at the practitioner's school, the results showed a stanine score of at least four on the mathematics portion of the examination. Thirty-four percent of these algebra students received failing grades. Sixty-two percent of these failures were students with stanines of less than six of which fifty-four percent were in grades eleven or twelve. These test results indicate that eleventh and twelfth grade students customarily do worse than ninth and tenth grade students in Algebra I.

In the 1987-88 school year, a district wide Algebra I test was administered to 9,272 representing 83 percent of total enrollment. The results showed that only 42 percent of the questions were answered correctly in the district (Appendix A:25). The practitioner's school also answered only 42 percent of the questions correctly (Appendix B:26). A further breakdown of the district wide statistics revealed that students answered less than 42 percent of the questions correctly on three out of the four skills on linear equations (Appendix C:27) defined in the 1987-1988 curriculum guide (skills 4.11-4.13) (Appendix D:28).

An Algebra I pre-test on linear equations similar to the district wide test was administered by the practitioner to a target group of 15 students with a similar low ability level in linear equations (Appendix E:33). The mean score was 30 percent (Appendix F:35). The practitioner believes

that the minimum passing score should be 45 percent. The discrepancy between these mean scores is 15 percent.

This practicum increased the student's knowledge of linear equations by writing a Computer Assisted Instruction Program (CAI) in BASIC.

After successful completion of the practitioner's CAI, two main objectives were met: 1) a short term objective and 2) a long term objective. The short term objective increased the target group's score from 30 percent to 46 percent on linear equations as measured by the pre-test and post-test of the practicum. The practitioner would like to point out that the implementation period was four weeks.

The long term objective is to familiarize students with computers, thus increasing their motivation towards mathematics. In 1988, Aksu and Saygi said "...knowledge of mathematics is critical to the pursuit of many existing and emerging occupational fields..." (p.391). As a result of the practicum the target group will have a better understanding of how mathematics is used in real life situations.

CHAPTER II

RESEARCH AND SOLUTION STRATEGY

As pointed out in Chapter 1, Page 3, in addition to the fact that only 42 percent of the questions were answered correctly, a further examination of the results showed that the students answered less than 42 percent of the questions involving graphing and writing linear equations (Appendix C:27). These statistics are not unique to the school district. In fact,

> In the National Assessment of Educational Progress, 1978 (NAEP) assessment of knowledge and skills, the level of student performance on algebra skills in general was viewed as "disheartening". Nearly all items included in the assessment would be considered part of a typical first year algebra course, and about 2/3 of the 17-year olds reported that they had taken a year of Algebra I. However, items requiring use of algebra were answered correctly by only about 20-25 percent of the students. The study reports that graphing of lines receives a great deal of attention in both algebra and geometry classes, but student performance on such items was far lower than even the 20-25 percent correct for algebra items in general (Dugdale and Kibbey, 1983, p.4).

The following is an example of the type of question that caused the most difficulty for the students taking the NAEP:

> 'Given a coordinate set of axes and a ruler, 10 percent of the 17 year olds correctly drew the graph of Y=2X+1, and 7 percent correctly graphed the inequality Y<=2X+1. Four percent of the 17 year olds wrote the correct equation of a line when they were given the X- and Y- intercepts. Fifteen percent of the 17 year olds named the slope of the line 2Y=5X-8, and 11 percent named the

Y- intercept of the same line' (NAEP report as quoted by Dugdale and Kibbey, 1983, p.6).

One of the chief reasons for these poor test results is that the students find it very difficult to comprehend the concept of algebraic functional relationships. This breakdown of the mathematical educational process starts at the elementary level. "Educators at the elementary level have a tendency to teach mathematics by rote, thereby causing many students at the secondary level to develop a phobia about mathematics" (Hirogoyan, 1988).

As a result of this phobia, students do not develop basic familiarities with concepts before advancing to material that depends on those concepts. "When students are accelerated ahead into manipulations of ideas that they are not comfortable with, it becomes easier to memorize a rule than to make sense of mathematical problems" (Dugdale and Kibbey, 1983, p.4). In rote learning, a student merely memorizes and does not comprehend the mathematical concepts involved. "Students then become 'symbol-pushers' with no sense of what is actually happening in the mathematics and no sense of what might be a reasonable result" (Erwlanger, 1975 as quoted by Dugdale and Kibbey, 1983, p.4). "Once a student begins coping this way, the sense of the mathematics is lost [,] and the foundation for future work becomes memorized algorithms. As more and more of these algorithms accumulate in the student's math bank, it becomes difficult to keep them all straight" (Dugdale and Kibbey, 1983, p.4).

Mathematics teachers feel that of all the subjects taught in the high school curriculum, mathematics is the **only** one that has a direct application to the everyday life experiences of the students. Students often have the notion that mathematics is a subject that is strictly taught in a classroom and has no functional value in society. However, one of the major problems teachers of mathematics face is student anxiety towards mathematics. "Researchers, besides the effects of math-anxiety on math achievement, investigated the causes and developed some intervention strategies to overcome math-anxiety. Computer-assisted instruction is one example" (Aksu and Saygi, 1988, p.392). This anxiety is caused by the lack of student motivation and interest despite the fact that it has been pointed out that mathematics is an integral part of the student's everyday life.

"During the period from 1965 to 1975 many students, mathematics teachers, curriculum developers, and researchers successfully used computers to enhance teaching and learning in many different ways" (Bell, 1978, p.472). Computers in the classroom are becoming a major part of the secondary school curriculum.

In 1981, Florida became the first state to make a direct statement regarding the use of computers in the school:

> Uses of computers in school mathematics:
> 1) To present unfamiliar concepts and principles in an interactive textbook format to students at computer terminals.
> 2) To provide individualized tutoring to students.

3) To drill students on new skills and help them practice these skills.
4) To diagnose learning problems and error patterns and provide remedial instruction to children.
5) To help students learn algorithms for solving many types of exercise and problems.
6) To give students an additional measure of motivation to learn mathematics (Bell, 1978, p.473).

According to Baird (1987), "to fully capitalize on the power of computers for teaching, traditional approaches to both teaching and the use of media may have to be altered" (p.49). For computer-enhanced learning to make dramatic permanent changes in secondary mathematics, educators need to ask and answer the following pertinent questions:

1) How can educators use computers in teaching mathematics to improve the poor results attained on standardized tests?
2) How can computers improve the applications of mathematics in everyday life?
3) How can the use of computers in the classroom motivate students to learn mathematics?
4) How can computers be used in helping students learn the various techniques of problem solving?

The practitioner solved the aforementioned problems with the use of a computer-assisted instruction (CAI) program in the classroom. According to a study of 30 secondary mathematics pupils ranging in ability level from Algebra I to Algebra II in the state of Mississippi, "the

experimental group mean [using CAI] was higher than the comparison group mean [without CAI] on the ACT composite score" (Acosta, Anderson, and Knight, 1988, p.86).

These results are not unique to the United States of America. In fact, these improvements have been amply observed on an International level. In a symposium of the International Commission on Mathematical Instruction held in Strassbourg, France, March 25-30, 1985: representatives from France, England, The Netherlands, Belgium, Canada, Italy, Australia, Federated Republic of Germany, Japan, and the United States of America stated unequivocally, 'computers offer a potential for dramatic improvement in mathematics instruction' (as quoted by Baird, 1987, p.66).

The practitioner's CAI is designed to increase the knowledge and the understanding of low level algebra students in their ability to write linear equations. "CAI math instruction has a lasting effect on math skills scores" (Baird, 1987, p.49). With the practitioner's guidance in the use of the CAI, the target group will achieve success in writing linear equations.

The CAI is titled "Fun with Algebra" and is to be used on any IBM or IBM compatible machine that is equipped with a color card and two disk drives. The student loads the diskette labeled PROJECT according to Appendix G:36. After the program is loaded correctly, "Fun with Algebra" is ready to be used:

1) The first display or screen is a title page.
2) This is followed by a menu which gives the student an opportunity to decide which one of the four parts of the program will be utilized.
3) Part I of the program is tutorial. It explains the concept of slope and Y-intercept with a display of various types of graphs and definitions.
4) Part II offers an opportunity to use the knowledge gleaned in Part I. The student is taught how to write a linear equation when both the slope and the Y-intercept are known.
5) The next screen reads "Now let's try one." On the following screen the student is given an opportunity to write a linear equation given the slope and the Y-intercept.
6) The problems in writing linear equations are chosen randomly by the computer to prevent repetition of the problems from occurring. After each written linear equation, the student receives instantaneous feedback regarding the success or failure in writing the linear equation. If the student fails to write the correct linear equation, then the option of trying another problem of similar difficulty or of reviewing what was learned previously is made available.

IT MUST BE NOTED THAT STEP 6 IS REPEATED IN EVERY PHASE OF PART II OF THE PROGRAM.

7) At this point the program presents two problems of greater difficulty:

   a) Where the slope and a point lying on the line are known.

   b) Where only two points lying on a line are known. This is more difficult than (a) (Appendix H:38).

8) Part III of the program is a test on what has been learned. The computer presents ten questions that are randomly selected. The student is given a computerized result for each question with such statements as "GREAT" or "INCORRECT - the correct answer is -." At the conclusion of the test, the student is given a computerized total result.

9) At this point the computer asks for the student's name. After the student inputs his/her name, his/her name and score are stored in a computer file. This file is called "NAME.FIL" (Appendix G:36). With this file the practitioner has an opportunity for constant

reference and analysis of the target group's work.

10) Part IV is a "STOP ROUTINE." This ends the program.

"Microcomputers are a valuable tool for teaching concepts in mathematics, particularly when the computer activities are integrated meaningfully into the curriculum" (Ball, 1988, p.472).

Another major strong point of the CAI is that teacher or pupil absence is not a deterrent to the learning process, since the CAI is "user-friendly" (Appendix I:40).

CHAPTER III

METHODOLOGY

Resources

The practitioner attended a series of seminars specifically geared for teachers of mathematics at the secondary level. At these seminars, the main objective was to equip these educators with mathematical techniques to incorporate the use of mathematics in the everyday life of the pupil. It must be an integral part of the daily life of the student.

The practitioner received invaluable assistance in developing the CAI from the mathematics and computer resident of the district's academy of the teaching arts. The mathematics chair-person at the practitioner's school was a main source of teaching techniques in administrating the CAI to the target group . In addition, the practitioner had many discussions on the value of computers in secondary education with a few retired principals from a secondary school system of a major city in the United States.

One of the basic materials necessary to implement the CAI is one floppy diskette labeled "Project." The target group is required to have pencil and paper at the computer terminal; these are essential in solving any mathematics problem whether using a textbook or a computer.

The time element for this practicum was four weeks. During the first week, the practitioner administered a pre-test similar to the district wide Algebra I test. The second and third weeks were devoted to

introducing the target group to the CAI. During the final week, the practitioner administered a post-test similar to the pre-test. It should be noted that all testing was administered during the practitioner's 40-minute lunch periods.

Five Tandy 1000HX and one disk drive were the necessary pieces of equipment to administer the CAI.

Monitoring

The practitioner systematically supervised each students work results as the CAI developed on screen. In the event that a student had difficulty and needed assistance, the student raised his/her hand to attract the attention of the practitioner. On many occasions, the practitioner spotted a student's difficulty, and immediately assisted in correcting it.

When the practitioner first introduced the CAI, "Fun with Algebra," to the target group, the idea of having *fun with algebra* was entirely different from what the target group thought of algebra. As a matter of fact, the target group found the statement very amusing. This immediately aroused their interest in the program.

The first three steps on pages 9-10 were achieved rather quickly. However, step four where the student had to use the knowledge gleaned in Part I of the CAI, the student had difficulties. This was the first time the student was taught, via the CAI, how to write a linear equation when both the slope and y-intercept are known. Immediately, a majority of the target

group requested assistance from the practitioner. In order to overcome these difficulties, the practitioner consulted with local educators and the mathematics/computer resident for the district's academy of the teaching arts. The result of these consultations was a mid course correction where the practitioner re-programmed the CAI to give the student the opportunity to review the material previously learned in the tutorial section; or review a sample problem depending on the particular phase of the CAI that the student had difficulty solving.

Steps five and six on page 10, the target group did not find difficult.

In step seven (part a) the students had difficulties in solving for the y-intercept, and in (part b) the difficulties occurred in solving for the slope. Both of these problems were solved with a mid course correction similar to the one in step four.

Step eight on page 11, is an integral part of the CAI. An educator once said, "Nothing succeeds like success." In this part of the CAI, the computer presents ten randomly selected questions. The student is given a computerized test result for each question with such statements as "GREAT" or "INCORRECT - the correct answer is ---." In all probability, this will be the first time the student received a complimentary grade in any phase of algebra. This is an invaluable morale builder.

Evaluation

The target group in the pre-test (Appendix E:33), developed and administered by the practitioner, achieved an average score of 30 percent correct based on ten questions. After completion of the tutorial and practice sections of the CAI, the program administered a test to assure the student of his/her success of failure in the program.

The practitioner administered a post-test (Appendix K:42) based on the precepts of the pre-test. The results proved beyond a doubt that the CAI is an extremely important educational tool in improving a student's ability to write linear equations.

Based on the practitioner's assessment of the program, this **CAI** can be extended to aid students in the concepts of solving basic algebraic equations.

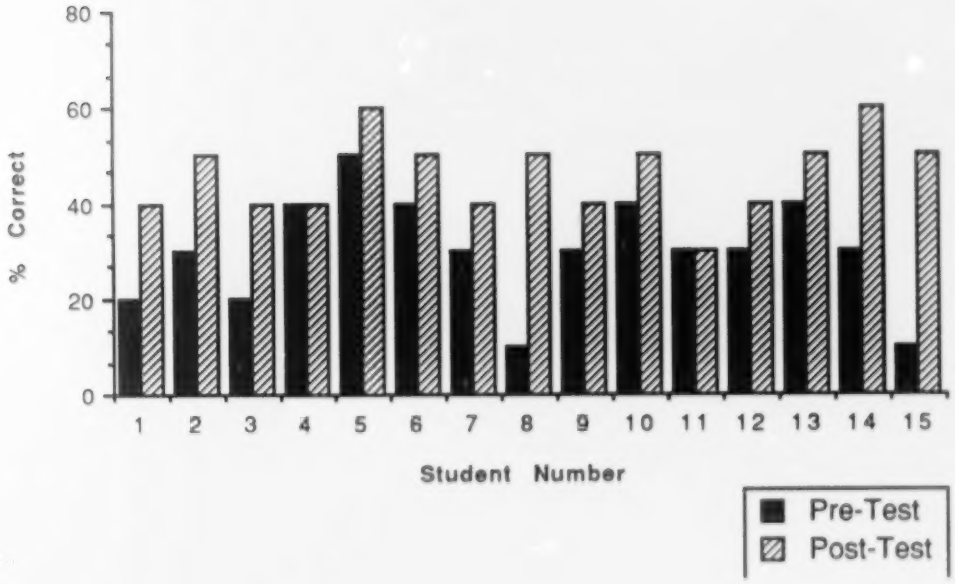
CHAPTER IV
RESULTS

The target group consisted of 15 students in the practitioner's class whose test scores over the fall semester of the 1988-89 school year were between 40 and 50 percent (Appendix J:41), while the lowest passing grade in the district was 65 percent. The target group showed a complete lack of comprehension in the concepts of algebraic linear equations. This was proved conclusively in a pre-test administered by the practitioner where the average score of the target group was 30 percent (Appendix F:35). The 30 percent figure is far below the mean score of 42 percent on the district-wide algebra examination (Appendix A:25).

At the conclusion of the four week implementation period of the CAI program, the practitioner administered a post-test (Appendix K:42) consisting of ten questions similar in format and difficulty to the pre-test. The test results showed that the target group achieved an average of 46 percent correct. (Appendix L:44) This figure is well above the target group's pre-test results and is one percent above the practitioner's expectancy statistic on page four.

TABLE I

A Comparison of Individual Students' scores on the Practitioner's Pre and Post-Test



The statistical evidence of the post-test administered to the target group proved conclusively that the CAI is an invaluable educational tool in teaching algebraic linear equations to under achievers in mathematics.

The long-term objective as pointed out on page four was enhanced as evidenced by the results of the second Attitudinal Survey administered to the target group.

ATTITUDINAL SURVEY

This survey was designed to determine student attitudes toward linear equations. A pre and post-attitudinal survey was administered to the target group:

1) Rank the following academic subjects in order of preference.
(1) favorite, (2) next to favorite, (3) least favorite:

	Pre			**Post**		
	1	2	3	1	2	3
English	4	8	3	3	8	4
Social Studies	10	3	2	9	4	2
Mathematics	1	4	10	3	3	9

2) Do you enjoy mathematics?

	yes	**no**
Pre	1	14
Post	3	12

3) Can you recognize a linear equation?

	yes	**no**
Pre	5	10
Post	12	3

4) Do you know the mathematical definition of the term slope?

	yes	no
Pre	9	6
Post	14	1

5) Do you know the mathematical definition of the term y-intercept?

	yes	no
Pre	4	11
Post	13	2

6) Can you write the linear equation given the slope and y-intercept?

	yes	no
Pre	3	12
Post	5	10

7) Can you write the linear equation given the slope and a point that lies on the line?

	yes	no
Pre	2	13
Post	4	11

8) Can you write a linear equation given two points that lie on the line?

	yes	no
Pre	1	14
Post	2	13

9) Do you like the way mathematics has been taught to you?

	yes	no
Pre	0	15
Post	8	7

10) Do you think that you will ever use algebra after you finish school?

	yes	no
Pre	0	15
Post	5	10

It must be noted that the target group's favorite subject showed a marked percentage increase between the pre and post-attitudinal survey. This percentage is further re-enforced in the target group's answer to the second question. The statistical evidence based upon the practitioner's target group's answers prove that the CAI is not only an invaluable tool in algebra, but is also a motivating force in improving the attitudes of low level achievers.

CHAPTER V

RECOMMENDATIONS

1) The practitioner believes that based on the statistical results of this practicum, the CAI is not only an invaluable tool in teaching low achievers in algebra, but also should become an integral tool in teaching low achievers in all secondary academic areas.

2) The practitioner recommends that inservice training courses on computer education be given to all secondary teachers of academic subjects. These courses would emphasis the adaptability of computers in the educational environment. The specifics of these courses would be two fold:

a) To educate teachers in computer literacy.

b) To introduce the teachers to the various types of software that are available.

3) The practitioner recommends that each school should have a library equipped with the up-to-date research in computer education.

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APPENDIX

APPENDIX A

1988 SUMMARY OF ALGEBRA I PRELIMINARY TEST RESULTS
DISTRICT WIDE

ENROLLED	*T-LT16	*T-GT15	*AVG. CORRECT
11,147	29 (0%)	9,272 (83%)	12.5 (42%)

*

T-LT16 = The number of students answering (correctly or incorrectly) less than 16 test questions.

T-GT15 = The number of students answering (correctly or incorrectly) greater than 15 test questions.

AVG. CORRECT = The % correct is the number of items answered correctly divided by the number of items on the test (30).

** All the statistics in the practicum are based on T-GT15.

APPENDIX B

1988 SUMMARY OF ALGEBRA I PRELIMINARY TEST RESULTS
PRACTITIONER'S SCHOOL

ENROLLED	*T-LT16	*T-GT15	*AVG. CORRECT
389	0 (0%)	333 (83%)	12.7 (42%)

*

T-LT16 = The number of students answering (correctly or incorrectly) less than 16 test questions.

T-GT15 = The number of students answering (correctly or incorrectly) greater than 15 test questions.

AVG. CORRECT = The % correct is the number of items answered correctly divided by the number of items on the test (30).

** All the statistics in the practicum are based on T-GT15.

APPENDIX C

1988 SUMMARY OF ALGEBRA I PRELIMINARY TEST RESULTS

SKILLS: LINEAR EQUATIONS

DISTRICT WIDE

SPS CODE AND ITS CONTENT	* % COR	ADJ. T-GT15	ADJ. % COR
4.03 Determine solutions of a linear equation in 2 variables; write and graph the equation	42	9,207	42
4.04 Determine the slope of a line when given 2 points or an equation of the line	36	9,198	36
4.05 Graph a linear equation given slope and y-intercept, or slope and a point on the line	33	9,226	33
4.06 Determine a linear equation given slope and y-intercept, slope and a point, or 2 points	31	9,184	31

* % COR. = A test question is counted whether or not the student answered the question.

ADJ. T-GT15 = Uses the number of students that answered (correctly or incorrectly) greater than 15 test questions.

ADJ. COR = Uses the number of questions answered correctly.

APPENDIX D

ALGEBRA I COURSE CURRICULUM

Major Objective 1: PERFORM OPERATIONS INVOLVING NUMBERS, SETS, AND VARIABLES.

- *1.1 Solve problems involving whole numbers, fractions, decimals and percents
- *1.2 Simplify numerical expressions which involve indicated arithmetic operations, powers or grouping symbols
- *1.3 Find the union and intersection of sets
  - *1.3.1 Demonstrate knowledge of subsets, equal sets, equivalent sets, disjoint sets, the empty set, finite and infinite sets
  - 1.3.2 Construct and interpret Venn diagrams
  - 1.3.3 Demonstrate knowledge of one-to-one correspondences
- *1.4 Evaluate an expression containing variables, when given the values of the variables
- *1.5 Translate word phrases or sentences into mathematical expressions or sentences
- 1.6 Determine whether a statement involving a quantifier is true or false

Major Objective 2: UNDERSTAND BASIC PROPERTIES OF REAL NUMBERS.

- *2.1 State and apply the eleven field properties of real numbers
- 2.2 State and apply the properties of zero
- 2.3 State and apply the definition of absolute value
- *2.4 State and apply the properties of equality
- *2.5 State and apply the order properties
- *2.6 Simplify algebraic expressions using the field properties
- 2.7 Solve equations and word problems using the field properties and the properties of equality
- 2.8 Solve inequalities using the field properties and the order properties

Major Objective 3: SOLVE AND USE FIRST-DEGREE EQUATIONS AND INEQUALITIES.

Appendix D (Continued)

*3.1 Solve linear equations over the rational numbers and graph their solution sets
*3.2 Solve inequalities in one variable and graph their solution sets
3.3 Solve equations in one variable involving absolute value
*3.4 Solve word problems whose solutions require stating and solving first-degree equations or inequalities
3.4.1 Solve problems by using proportions
3.5 Solve conjunctions and disjunctions of inequalities and graph their solution sets

Major Objective 4: UNDERSTAND BASIC CONCEPTS OF FUNCTIONS, RELATIONS, AND THEIR GRAPHS.

*4.1 Define a relation and state its domain and range
*4.2 Determine if a relation is a function
*4.2.1 Interpret standard functional notation
4.2.2 Translate from functional notation to rule form, and from rule form to functional notation
4.2.3 Determine the value of a function for a given replacement
4.3 Graph ordered pairs of numbers and state the coordinates of points in a coordinate plane
4.4 Graph functions and relations with finite domains in a coordinate plane
*4.5 Identify polynomial functions, specifically linear and constant functions
*4.6 Identify the identity function
*4.7 Identify the zeros of a function
*4.8 Graph linear equations in two variables in a coordinate plane
*4.9 Solve problems involving direct variation
*4.10 Solve problems involving inverse variation
4.11 Identify the standard form and the slope-intercept form of a linear equation
*4.12 Identify the slope and y-intercept of a non-vertical line given its equation
*4.12.1 Graph and find an equation of a non-vertical line given its slope and y-intercept

Appendix D (Continued)

*4.12.2 Find an equation of a line given the slope of the line and the coordinates of a point on it

*4.12.3 Find the slope and an equation of a line given the coordinates of two points in the line

*4.12.4 Determine an equation of a line parallel to a given line, containing a particular point

*4.12.5 Determine an equation of a line perpendicular to a given line, containing a particular point

4.13 Graph linear inequalities in two variables

Major Objective 5: SOLVE AND USE SYSTEMS OF LINEAR EQUATIONS AND INEQUALITIES IN TWO VARIABLES.

*5.1 Find the solution set of a system of two linear equations in two variables

*5.1.1 Solve a system of two linear equations by substitution

*5.1.2 Solve a system of two linear equations by graphing

*5.1.3 Solve a system of two linear equations by linear combinations

5.2 Solve by graphing the solution set of two inequalities in two variables

*5.3 Recognize graphically the number of solutions of a linear system

*5.4 Identify and use systems of linear equations to solve problems

Major Objective 6: SOLVE PROBLEMS INVOLVING INTEGRAL EXPONENTS.

*6.1 Apply the property $a^m \cdot a^n = a^{m+n}$

*6.2 Apply the property $a^m / a^n = a^{m-n}$

*6.3 Apply the property $(ab)^n = a^n \cdot b^n$

*6.4 Apply the property $(a/b)^n = a^n / b^n$

*6.5 Apply the property $(a^m)^n = a^{mn}$

*6.6 Apply the property $a^{-n} = 1/a^n$

*6.7 Identify the value of a^* , a is not equal to 0

Appendix D (Continued)

*6.8 Simplify expressions of monomials and polynomials using the laws of exponents

Major Objective 7: SOLVE PROBLEMS INVOLVING POLYNOMIALS AND RATIONAL ALGEBRAIC EXPRESSIONS

- 7.1 Arrange the terms of a polynomial in descending order
- *7.2 Perform the four basic operations with polynomials
  - *7.2.1 State the degree and number of terms of a given polynomial
  - 7.2.2 Evaluate polynomials and rational expressions when given the values of variables
  - 7.2.3 Determine whether an expression is or is not a polynomial
- 7.3 Express an algebraic fraction in lowest terms
- 7.4 Multiply or divide algebraic fractions
- 7.5 Add or subtract algebraic fractions with like or unlike denominators
- 7.6 Solve word problems involving the use of rational algebraic expressions and equations
- 7.7 Solve algebraic formulas for one particular variable

Major Objective 8: FACTOR POLYNOMIALS.

- *8.1 Identify the prime factors of a given polynomial
  - *8.1.1 Factor polynomials using the distributive property, identifying the greatest monomial factor
  - *8.1.2 Factor the difference of two squares
  - *8.1.3 Factor perfect square trinomials
  - *8.1.4 Factor quadratic trinomials
  - *8.1.5 Factor polynomials by grouping
  - *8.1.6 Factor polynomials completely using any combination of the above

Major Objective 9: SIMPLIFY RATIONAL AND IRRATIONAL EXPRESSIONS.

Appendix D (Continued)

*9.1 Identify rational numbers and irrational numbers
*9.2 Express terminating or repeating decimals in fractional form
9.3 Find rational approximations for irrational square roots
*9.4 Determine the values of rational expressions given the values of the variables
*9.5 Identify any restrictions on the variables in a rational expression
*9.6 Determine equivalent expressions of given rational expressions
*9.7 Perform the four basic operations with rational expressions
*9.8 Solve equations containing rational expressions
9.8.1 Solve word problems involving rational expressions
*9.9 Simplify radical expressions
9.9.1 Rationalize denominators containing radicals
9.10 Perform the four operations on two or more expressions containing radical expressions
9.11 Multiply or divide binomials containing radicals
9.12 Solve an equation containing a radical
*9.13 Apply the Pythagorean Theorem
*9.14 Apply the Distance Formula
*9.15 Rewrite radical expressions by using rational exponents
*9.16 Rewrite expressions with rational exponents by using radicals

Major Objective 10: SOLVE AND USE QUADRATIC EQUATIONS.

*10.1 Express quadratic equations in standard form
*10.2 Solve quadratic equations by factoring
*10.3 Solve quadratic equations by using the quadratic formula
*10.4 Solve quadratic equations by completing the square
10.5 Use quadratic equations to solve word problems

Special emphasis should be given to those objective denoted by an * since these are contained in the objectives of the Dade County Algebra I Test.

APPENDIX E

PRACTITIONER'S PRE-TEST

1) What is the slope of the line whose equation is y=6x-2/5?

a) 6
b) 1/6
c) -2/5
d) -6

2) What is the y-intercept of the line whose equation is y=3x-2?

a) 3
b) -2
c) 3/2
d) -2/3

3) A line has a y-intercept of -2 and a slope of 5. What is the equation of the line?

a) y = 5x - 2
b) y = 5x + 2
c) y = 2x + 5
d) y = -2x - 5

4) What is the equation of the line whose slope is -3 and whose y-intercept is 2?

a) -3x - y = 2
b) -3x - y = -2
c) -3x + y = 2
d) -3x + y = -2

5) What is the equation of a line whose slope is 1/2 and passes through the point (1,2)?

a) 2y = 1/2x + 3
b) y = 1/2x + 3/2
c) 3y = 1/2x + 3
d) y = 1/2x - 3/2

Appendix E (Continued)

6) A line with a slope of -2/3 passes through the point of (0,1). What is the equation of the line?

a) $2x + 3y = 3$
b) $2x + 3y = 1$
c) $2x - 3y = -3$
d) $3x - 4y = -y$

7) What is the slope of the line passing through the points (4,7) and (-1,3)?

a) 3/10
b) 4/5
c) 4/3
d) 5/4

8) Find the slope of the line passing through the points (1,-2) and (4,2).

a) 1/2
b) -4/3
c) 4/3
d) 0

9) What is the equation of a line that passes through (0,4) and (-2,0)?

a) $y = yx + 2$
b) $y = 2x + 4$
c) $y = -2x + 4$
d) $y = -4x + 2$

10) What is the equation of a line which passes through (2,7) and (3,10)?

a) $3y = x - 1$
b) $3y = x + 1$
c) $y = 3x + 1$
d) $y = 3x - 1$

APPENDIX F

SUMMARY OF RESULTS OF PRACTITIONER'S PRE-TEST

# OF STUDENTS	# OF QUESTIONS	AVG. # CORRECT	MEAN SCORE
15	10	3	30%

APPENDIX G

EQUIPMENT AND INSTRUCTIONS FOR UTILIZING THE CAI "FUN WITH ALGEBRA"

Equipment Needed:

1) IBM or IBM compatible machine with a color card
2) One Disk Drive
3) One Diskette labeled "PROJECT"

Directions for Loading Diskette:

1) Put "PROJECT" diskette in disk drive #1.
2) Turn computer and monitor on.
3) When the computer asks for the new date, press ENTER twice.
4) When "A>" appears on the screen, type BASICA.
5) When "OK" appears press the F3 key and type A: PROJECT then press ENTER.
6) When "OK" appears on the screen again, press the F2 key or type RUN.
7) The title page screen will now appear.
8) At this time the student just follows the on-screen instructions to utilize "Fun with Algebra."

Appendix G (Continued)

Directions for Utilizing "NAME.FIL":

1) After the student has completed the test and has input his/her name into the computer, the computer will take the student back to the menu.

2) At this time the teacher will instruct the student to pick choice #4 ("STOP ROUTINE").

3) The program will now end.

4) To utilize "NAME.FIL" the **teacher** must type SYSTEM and press ENTER. This will take the computer out of BASIC.

5) When "A>" appears, type TYPE A: NAME.FIL and press ENTER.

6) Now a listing of all the students that have utilized the test in "Fun with Algebra" will appear.

7) To get a print-out (hard-copy), just press the Print Screen key.

APPENDIX H

EXAMPLES

(A) The slope and a point lying on the line are known.

Slope (m) = 2
Point = (0,1) remember x = 0 and y = 1

The formula for a linear equation is: $y = mx + b$.

1) First substitute m into the equation: $y = 2x + b$.

2) Now substitute the appropriate coordinates for x and y into the equation, and solve for the y intercept (b).

$1=2*0+b$
$1=b$

3) Now write the linear equation: $\underline{y = 2x + 1.}$

(B) Only two points lying on the line are known.

Point 1 = (0,1) remember x1 = 0 and y1 = 1
Point 2 = (1,2) remember x2 = 1 and y2 = 2

1) First solve for the slope (m). Remember the formula for the slope is (y2 - y1)/(x2 - x1).

$m = (2-1)/(1-0) = 2/1 = 2$

2) Now substitute the slope into the equation of a line. Remember the formula for a linear equation is y=mx+b.

$y = 2x + b$

3) Now choose either Point 1 or Point 2. It does not matter which point is chosen so let's substitute Point 1 into the equation, and solve for the y-intercept (b).

$1 = 0*x + b$
$1 = b$

Appendix H (Continued)

4) Now write the equation of the line: $y = 2x + 1$.

APPENDIX I

DEFINITION

"User-friendly" signifies that the man/computer relationship is, relatively, so simple that the CAI can be utilized effectively by low level students in mathematics and all other secondary subjects. The most effective pieces of software are "user-friendly."

The advantage of writing "user-friendly" software is that the user does not need outside assistance to utilize the program. All of the directions that are necessary to operate the program are given as on-screen instructions. After the program is loaded correctly, the user can operate the software at his/her own pace without any intervention from an instructor or supervisor.

APPENDIX J

TARGET GROUPS TEST SCORES FOR FALL SEMESTER OF THE 1988-89 SCHOOL

Student #	* Average	Letter Grade
1	45	F
2	42	F
3	40	F
4	49	F
5	48	F
6	47	F
7	41	F
8	41	F
9	43	F
10	42	F
11	40	F
12	44	F
13	46	F
14	48	F
15	49	F

* Average = Based on 18 grades for the fall semester of 1988-89 school year in algebra.

APPENDIX K

PRACTITIONER'S POST-TEST

1) What is the slope of the line whose equation is y=3x-1/4?

a) 3
b) 1/3
c) -1/4
d) -3

2) What is the y-intercept of the line whose equation is y=5x-4?

a) 5
b) -4
c) 5/4
d) -4/5

3) A line has a y-intercept of -3 and a slope of 7. What is the equation of the line?

a) y = 7x - 3
b) y = 7x + 3
c) y = 3x + 7
d) y = -3x - 7

4) What is the equation of the line whose slope is -4 and whose y-intercept is 3?

a) -4x - y = 3
b) -4x - y = -3
c) -4x + y = 3
d) -4x + y = -3

5) What is the equation of a line whose slope is 1/4 and passes through the point (2,4)?

a) 2y = 1/4x + 7
b) y = 1/4x + 7/2
c) 7y = 1/4x + 7
d) y = 1/4x - 7/2

Appendix K (Continued)

6) What is the slope of the line whose equation is $3x-4y = 5$?

a) -5/4
b) -3/4
c) 3/4
d) 4/3

7) What is the slope of the line which contains the points (3,5) and (-6,1)?

a) 9/4
b) 4/9
c) -4/3
d) -3/4

8) Select the equation of a line which passes through (2,5) and (4,11).

a) $y = 3x + 1$
b) $y = 3x - 1$
c) $3y = x + 1$
d) $3y = x - 1$

9) Which equation expresses the equation $2x + y = 4$ in slope/intercept form?

a) $y = 2x - 4$
b) $y = 2x + 4$
c) $y = -2x + -4$
d) $y = -2x + 4$

10) What is the equation of a line whose slope is 1/2 and whose y-intercept is 3?

a) $6x - 2y = -1$
b) $x + 2y = 6$
c) $x - 2y = -6$
d) $x - 2y = -3$

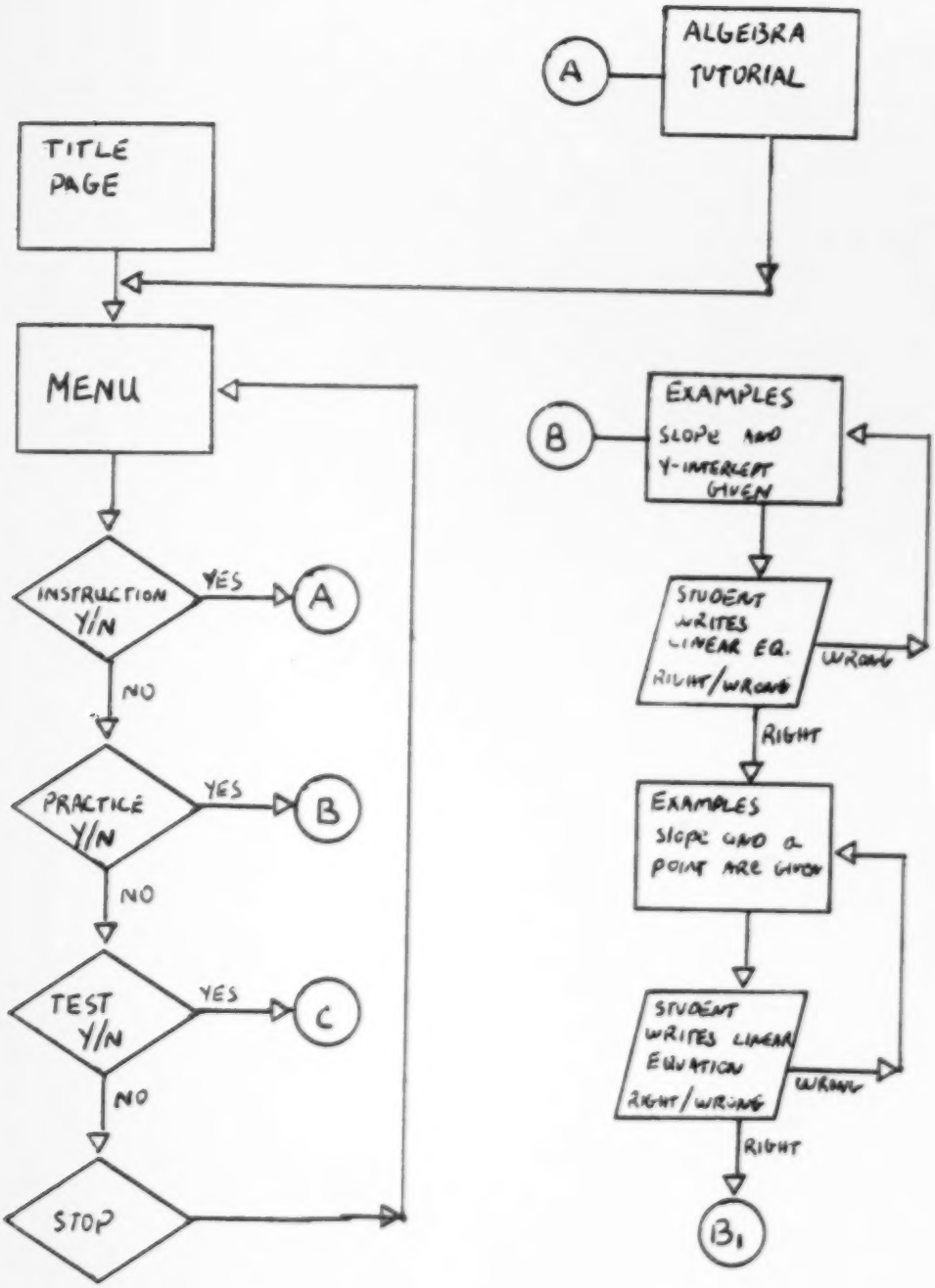
APPENDIX L

Summary of Results of Practitioner's Post-Test

# of Students	# of Questions	Avg. # Correct	Mean Score
15	10	4.6	46%

APPENDIX M

FLOW CHART



APPENDIX (CONTINUED)